

UNITED STATES PATENT APPLICATION

FOR

NOVEL CURSOR CONTROL SYSTEM

Inventor:

Dan Kikinis

Prepared by:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
12400 Wilshire Boulevard
Seventh Floor
Los Angeles, California 90025-1026
(408) 720-8598

Attorney's Docket No: 04688P012

"Express Mail" mailing label number: EL627471296US

Date of Deposit: April 27, 2001

I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Assistant Commissioner for Patents, Washington, D. C. 20231

Carrie Boccaccini

(Typed or printed name of person mailing paper or fee)

Carrie Boccaccini
(Signature of person mailing paper or fee)

4-27-2001

(Date signed)

NOVEL CURSOR CONTROL SYSTEM

This application claims priority to provisional application number 60/200,817, filed April 27, 2000, entitled "Novel Cursor System" which is hereby incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to interaction with televisions and more specifically to control of a cursor on a television utilizing a wireless remote control device.

Description of the Related Art

An electronic programming guide on a television can behave in many ways similar to applications on a personal computer. However, televisions do not have cursors and cursor control devices built in as do personal computers. Moreover, the typical user on a couch is not in a position to efficiently use a conventional mouse or trackball. One alternative currently in use is a tiny black ball, integrated as a trackball into an infrared remote control, but this arrangement can be hard to handle. Also, to untrained users, such a device may seem awkward because it lacks the intuitive nature of pointing to an object with the remote control.

Another alternative in current use utilizes selection control arrow keys, which allow a selection highlight in a program to be moved in one of four directions depending

on which arrow key is pressed. Again, this lacks the intuitive nature of pointing to an object. Furthermore, objects on the screen may not simply be left, right, up or down from adjacent objects, leading to unexpected jumps in the selection highlight.

Therefore, what may be advantageous is a remote control device that allows a user to point to an object on a television screen and then allows the user to choose the selected object on the television screen.

SUMMARY OF THE INVENTION

A method and apparatus for a novel cursor control system is disclosed. In one embodiment, the invention is a method of manipulating a cursor on a tv screen utilizing a wireless remote control. The method includes detecting a location on the screen 5 pointed to by the remote control. The method also includes Transmitting the location to a set-top box.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not limitation in the accompanying figures.

Figure 1 illustrates an embodiment of a system.

5 Figure 2 illustrates an embodiment of an LCD screen.

Figure 3 provides a flow diagram illustrating an embodiment of a process.

10 Figure 4 provides a flow diagram illustrating an alternate embodiment of a process.

Figure 5 provides a flow diagram illustrating another alternate embodiment of a process.

15 Figure 6 illustrates additional aspects of the embodiment of the system of Figure 1.

Figure 7 provides a flow diagram illustrating yet another alternate embodiment of a process.

20 Figure 8 illustrates an embodiment of a machine which may be used to implement one or more components of a system.

DETAILED DESCRIPTION

A method and apparatus for a novel cursor control system is described. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, 5 however, to one skilled in the art that the invention can be practiced without these specific details. In other instances, structures and devices are shown in block diagram form in order to avoid obscuring the invention.

Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the 10 embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments mutually exclusive of other embodiments.

A method and apparatus for controlling a cursor using a wireless remote control is described. This method and apparatus uses a detector in the remote control and a processor in a set-top box to determine what the remote control is pointing at, and the set-top box then processes this information to determine where or how to display a cursor on a tv screen or similar display. In one embodiment, a method or apparatus involves a tracking cursor on a screen which moves around as the user moves the 20 remote control. An alternative embodiment employs a method or apparatus which includes a light source allowing a user to grab a cursor from its current location and move it to a desired location. Note that a wireless remote control may take any number of forms, using technology such as infrared, radio, modulated radio frequency, laser, for

example. Also, devices such as PDAs using software and possibly utilizing add-on hardware that collectively allow for remote control of a television system may be referred to as wireless remote control devices.

Figure 1 illustrates an embodiment of a system. This includes screen 100, 5 wireless remote control device 125, and set-top box 199. Screen 100 includes scan lines 101, invisible horizontal retrace lines 102 and invisible vertical retrace lines 103. Symbolically, scan lines are numbered with number set 104. In one embodiment, on line 2 is object 110, that the user would like to choose using remote control 125. Line of sight 120 points to object 110. Sensor 121 in the remote control 125 can sense when 10 the scan of a tv electron beam (or similar scan on other display devices) touches the area of object 110. Additionally, in some embodiments, sensor 121 can sense when the motion of remote control 125 causes the line of sight to cross a boundary in an LCD screen. Accordingly, the location of object 110 may be calculated by timing the scan relative to the Hsync and Vsync signals. However, as this is a wireless remote control, 15 there is no way to supply a pulse representing the scan of the screen at the targeted spot via a wired connection, as had been done in video games for example.

Instead of using wires, the pulse is processed by microcontroller 123 and sent as infrared signal 130 by infrared transmitter 124 to set-top box 199. Set-top box 199 receives the infrared signal in receiver 150 and then uses special controller 180, which 20 may be implemented in either hardware, software, or some combination thereof, to compare the infrared signal 130 to video signal(s) 171. Calculations based on this comparison provide a location 181 which is furnished to a processor 198 (or similar device) to position the cursor as would a normal cursor-positioning signal. Thus, the

system controller 198 (processor) can make the cursor visible by programming video chip 160, which may be a 2-D or 3-D video chip and which supplies video signals 170 to screen 100.

In one embodiment, the tracking cursor moves around the screen in response to 5 the movements of the remote control 125 as detected by the detector 121 (sensor) and processed by the remote control 125 and set-top box 199. In an alternative embodiment, light source 127, for example a laser LED or other light source, is included in the remote control 125. Light source 127 is aimed at semi-mirror 126 which is interposed in the line of sight beam 120 between an aperture in the remote control 125 10 housing and sensor 121. Blinds 122a and 122b may be included to generate a narrow focus for line of sight beam 120, resulting in greater accuracy both in picking up a signal and in sending a light spot. The light spot may be a red light as used in laser pointers for example. The blinds 122a and 122b are focus elements, and may be implemented with other devices, such as lenses for example. In other embodiments, conventional 15 lens systems may be utilized to accomplish a function similar to that of the focus elements 122a and 122b, such as but not limited to plastic lenses and lens arrays for example.

Figure 2 illustrates an embodiment of an LCD screen as an example of flat panel technology, which may also include but is not limited to plasma, EL, organic, FET, and 20 other flat panel technologies for example. Those (flat panel) screens do not necessarily use the same scan process used in CRT screens, so other methods of calculating a position may be necessary. Large LCD screens and some other flat panel display technologies do have multiple sectors. In this exemplary illustration, LCD screen 200 is

illustrated with sector boundaries numbered 1-5 in the horizontal and vertical directions. In the numbering scheme illustrated, a sector may be addressed with a pair of coordinates, first a horizontal, then a vertical coordinate. Thus, sector 210 has coordinates 1,1. Similarly, sector 220 has coordinates 1,4, sector 230 has coordinates 5 3,3 and sector 240 has coordinates 4,5. As illustrated, the coordinates correspond to the righthand and bottom boundaries of the sector. However, other numbering schemes and addressing schemes may be utilized to uniquely identify sectors on an LCD. It will be appreciated that other, similar approaches may be applied depending on actual screens connected. In some cases the user may have to go through a setup or 10 initialization routine to configure the system to the correct type of screen.

With LCD screens and/or projector screens, the user may have to grab the cursor (such as with a light spot) and move the cursor, with transitions across sector boundaries detected to track motion for example. The implied track of motion may be displayed based on which sector boundaries are crossed. The processing involved in 15 such a system may be accomplished in controller 180 for example. As will be appreciated, controller 180 may be a piece of software used with processor 198, specialized hardware, or some combination of the two. Furthermore, as will be appreciated, the infrared system including elements 124, 130 and 150 may alternatively be implemented as a wireless system using radio-frequency transmission or inductive 20 transmission for example.

Figure 3 provides a flow diagram illustrating an embodiment of a process. This process, in one embodiment, illustrates a process of utilizing a remote control device to operate a cursor on a tv screen. At block 310, the cursor and remote control device are

initialized with respect to the system. At block 320, the cursor is manipulated by the remote control device, such as moving the cursor or selecting an item pointed to by the cursor. At block 330, the cursor is displayed by the system in accordance with the manipulations actually detected by the system. Some manipulations, such as moving 5 the cursor around in an area not corresponding to the screen may not be detected by the system, thus leading to no display of changes in the cursor. The manipulation and display portions of the process may be repeated, and, at times, the initialization process may be repeated.

Figure 4 provides a flow diagram illustrating an alternate embodiment of a 10 process. In one embodiment, the process illustrated relates to the process of sensing and updating the cursor location. At block 410, the current location of the cursor is sensed, such as by the method described with respect to Figure 1 previously. At block 420, the location of the cursor is transmitted to the controller, either as some form of explicit location, or as an indication of when a synchronizing signal was sensed. At block 430, the display of the cursor is updated based on the location transmitted at block 420. This process may be repeated as long as the system is active.

Figure 5 provides a flow diagram illustrating another alternate embodiment of a 15 process. At block 510, the cursor is grabbed, such as by having the remote control device pointed at the cursor (as illustrated by a light spot for example) and selecting the cursor for example. At block 520, the grab of the cursor is transmitted to the set-top box, thus informing it that the cursor is to be monitored. At block 530, the cursor is moved, such as by moving the remote control until it points at another portion of the screen. At block 540, the movement of the cursor is transmitted to the set-top box, thus 20

allowing for an update of the display of the cursor's position and potential detection of changes in what the cursor may select. This move and transmit portion of the process may be repeated and may occur over various time intervals, leading to either smooth motion of a cursor or jumps in the cursor's apparent location on the display. At block 5 550, the cursor is released by the user, such as by explicitly releasing the cursor. At block 560, the release is transmitted to the set-top box, thus allowing it to stop monitoring the cursor movements. As will be appreciated, the release need not be explicit, it may be implicit in other processes within the remote control device or the set-top box. For example, selection of an entry on a display may trigger an automatic 10 release, as may expiration of a timer at a predetermined time after either a grab or a last move of the cursor. Such implicit releases may be detected or determined in the set-top box, eliminating the need for transmission, or may be detected or determined in the remote control device and transmitted to the set-top box.

copying, distributing, or displaying this document in whole or in part without the prior written permission of the Copyright Owners is unlawful.

Figure 6 illustrates additional aspects of the embodiment of the system of Figure

1. Initialization of the system may be important to properly tracking movement of the cursor, and may depend on various environmental and system variables. As a result, determination of delays or latencies in processor 123, transmitter 124 and receiver 150 among other components (or paths such as line of sight 120 and transmission 130) in the embodiment of Figure 1 may be necessary. As illustrated, line of sight 120 is 20 pointed at target 108A which is displayed on screen 100 along with targets 108B and 108C. By pointing at the targets in a predetermined sequence or as instructed to by the system, the user may synchronize the system and allow for measurement of the delays in the system. Effectively, the system may be calibrated. Note that the number and

position of the targets is important only to the extent that they are known in advance for calculation purposes. Furthermore, correlation and calibration may be accomplished in a variety of ways, which may include other methods such as dynamically passing the remote control over a given part of the screen. Moreover, correlation may also involve

5 selecting targets or releasing targets in systems utilizing such features.

10

Figure 7 provides a flow diagram illustrating yet another alternate embodiment of a process. At block 710, a target is selected or pointed to. At block 720, the selection is transmitted, or alternatively the detected location is transmitted. At block 730, the transmission is correlated to known signals within a set-top box, resulting in a

10 determination of expected delays between an action at the remote control device and receipt of a corresponding transmission at the set-top box.

5

20

Figure 8 illustrates an embodiment of a machine which may be used to implement one or more components of a system. For example, the machine may implement the set-top box or the remote control with suitable changes or enhancements. The machine 800 includes a processor 810, a memory 820 coupled to the processor 810 and an interface 830 coupled to the processor 810. As will be appreciated, multiple processors 810, memories 820 and interfaces 830 may be included in a machine 800, and the processors 810, memories 820, and interfaces 830 may be implemented in a variety of ways, such that a processor 810 may be implemented as a general processor, or as a video processor such as that described earlier with respect to Figure 1. Moreover, it will be appreciated that a memory 820 may be expected to contain one or more of data or instructions suitable for use by the processor 810. Additionally, the processor 810, when executing instructions from the

memory 820, may be expected to perform a method associated with those instructions.

Memory 820 may be implemented as one or more of a variety of media such as those described later in this description.

Some portions of the detailed description are presented in terms of algorithms

5 and symbolic representations of operations on data bits within a computer memory.

These algorithmic descriptions and representations are the means used by those skilled in the art to most effectively convey the substance of their work to others skilled in the art. An algorithm as described here is generally conceived to be a self consistent sequence of acts or operations leading to a desired result. The acts are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared and otherwise manipulated. It has proven convenient at times principally for reasons of common usage to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, data or the like.

RECORDED IN 35MM FILM BY DIA

5

20

It should be borne in mind, however, that all of these in similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion it is appreciated that throughout the description discussions utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like refer to the action and processes of a computer system or similar electronic computing device that manipulates and transforms data represented as physical (electronic) quantities within the computer systems registers and memories into other data similarly represented as physical quantities within the computer system

memories or registers or other such information storage transmission or display devices. The present invention can be implemented by an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes or it may comprise a machine such as a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium such as but not limited to any type of disk including floppy disks, optical disks, CD roms and magnetic optical disks, read only memories, random access memories, EPROMS, EEPROMS, magnetic or optical cards or any type of media suitable for storing electronic constructions and each coupled to a computer system bus. Each of these media may be coupled to a computer system bus through use of an appropriate device for reading and or writing the media in question. Specialty apparatus may include a collection of readily available pieces or an application specific integrated circuit including a series of logic blocks for example. The blocks of Figures 7 or 8 may be suitable for implementation as logic blocks, as may other configurations of the method, system and apparatus described herein.

The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose systems may be used with programs in accordance with the teachings herein or it may prove convenient to construct more specialized apparatus to perform the required method. For example, any of the methods according to the present invention can be implemented in hard wired circuitry by programming a general purpose processor or by any combination of hardware and software. One of skill in the art will immediately appreciate that the

invention can be practiced with computer system configuration. Configurations other than those described below including hand held devices, multi processor systems, microprocessor based or programmable consumer electronics, network PCs, mini computers, main frame computers and the like. The invention may also be practiced in 5 distributed computing environments or tasks or performed by remote processing devices that are linked through a communications network. The required structure for a variety of these systems will appear from the description below.

10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
320
325
330
335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
505
510
515
520
525
530
535
540
545
550
555
560
565
570
575
580
585
590
595
600
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675
680
685
690
695
700
705
710
715
720
725
730
735
740
745
750
755
760
765
770
775
780
785
790
795
800
805
810
815
820
825
830
835
840
845
850
855
860
865
870
875
880
885
890
895
900
905
910
915
920
925
930
935
940
945
950
955
960
965
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
1035
1040
1045
1050
1055
1060
1065
1070
1075
1080
1085
1090
1095
1100
1105
1110
1115
1120
1125
1130
1135
1140
1145
1150
1155
1160
1165
1170
1175
1180
1185
1190
1195
1200
1205
1210
1215
1220
1225
1230
1235
1240
1245
1250
1255
1260
1265
1270
1275
1280
1285
1290
1295
1300
1305
1310
1315
1320
1325
1330
1335
1340
1345
1350
1355
1360
1365
1370
1375
1380
1385
1390
1395
1400
1405
1410
1415
1420
1425
1430
1435
1440
1445
1450
1455
1460
1465
1470
1475
1480
1485
1490
1495
1500
1505
1510
1515
1520
1525
1530
1535
1540
1545
1550
1555
1560
1565
1570
1575
1580
1585
1590
1595
1600
1605
1610
1615
1620
1625
1630
1635
1640
1645
1650
1655
1660
1665
1670
1675
1680
1685
1690
1695
1700
1705
1710
1715
1720
1725
1730
1735
1740
1745
1750
1755
1760
1765
1770
1775
1780
1785
1790
1795
1800
1805
1810
1815
1820
1825
1830
1835
1840
1845
1850
1855
1860
1865
1870
1875
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
2065
2070
2075
2080
2085
2090
2095
2100
2105
2110
2115
2120
2125
2130
2135
2140
2145
2150
2155
2160
2165
2170
2175
2180
2185
2190
2195
2200
2205
2210
2215
2220
2225
2230
2235
2240
2245
2250
2255
2260
2265
2270
2275
2280
2285
2290
2295
2300
2305
2310
2315
2320
2325
2330
2335
2340
2345
2350
2355
2360
2365
2370
2375
2380
2385
2390
2395
2400
2405
2410
2415
2420
2425
2430
2435
2440
2445
2450
2455
2460
2465
2470
2475
2480
2485
2490
2495
2500
2505
2510
2515
2520
2525
2530
2535
2540
2545
2550
2555
2560
2565
2570
2575
2580
2585
2590
2595
2600
2605
2610
2615
2620
2625
2630
2635
2640
2645
2650
2655
2660
2665
2670
2675
2680
2685
2690
2695
2700
2705
2710
2715
2720
2725
2730
2735
2740
2745
2750
2755
2760
2765
2770
2775
2780
2785
2790
2795
2800
2805
2810
2815
2820
2825
2830
2835
2840
2845
2850
2855
2860
2865
2870
2875
2880
2885
2890
2895
2900
2905
2910
2915
2920
2925
2930
2935
2940
2945
2950
2955
2960
2965
2970
2975
2980
2985
2990
2995
3000
3005
3010
3015
3020
3025
3030
3035
3040
3045
3050
3055
3060
3065
3070
3075
3080
3085
3090
3095
3100
3105
3110
3115
3120
3125
3130
3135
3140
3145
3150
3155
3160
3165
3170
3175
3180
3185
3190
3195
3200
3205
3210
3215
3220
3225
3230
3235
3240
3245
3250
3255
3260
3265
3270
3275
3280
3285
3290
3295
3300
3305
3310
3315
3320
3325
3330
3335
3340
3345
3350
3355
3360
3365
3370
3375
3380
3385
3390
3395
3400
3405
3410
3415
3420
3425
3430
3435
3440
3445
3450
3455
3460
3465
3470
3475
3480
3485
3490
3495
3500
3505
3510
3515
3520
3525
3530
3535
3540
3545
3550
3555
3560
3565
3570
3575
3580
3585
3590
3595
3600
3605
3610
3615
3620
3625
3630
3635
3640
3645
3650
3655
3660
3665
3670
3675
3680
3685
3690
3695
3700
3705
3710
3715
3720
3725
3730
3735
3740
3745
3750
3755
3760
3765
3770
3775
3780
3785
3790
3795
3800
3805
3810
3815
3820
3825
3830
3835
3840
3845
3850
3855
3860
3865
3870
3875
3880
3885
3890
3895
3900
3905
3910
3915
3920
3925
3930
3935
3940
3945
3950
3955
3960
3965
3970
3975
3980
3985
3990
3995
4000
4005
4010
4015
4020
4025
4030
4035
4040
4045
4050
4055
4060
4065
4070
4075
4080
4085
4090
4095
4100
4105
4110
4115
4120
4125
4130
4135
4140
4145
4150
4155
4160
4165
4170
4175
4180
4185
4190
4195
4200
4205
4210
4215
4220
4225
4230
4235
4240
4245
4250
4255
4260
4265
4270
4275
4280
4285
4290
4295
4300
4305
4310
4315
4320
4325
4330
4335
4340
4345
4350
4355
4360
4365
4370
4375
4380
4385
4390
4395
4400
4405
4410
4415
4420
4425
4430
4435
4440
4445
4450
4455
4460
4465
4470
4475
4480
4485
4490
4495
4500
4505
4510
4515
4520
4525
4530
4535
4540
4545
4550
4555
4560
4565
4570
4575
4580
4585
4590
4595
4600
4605
4610
4615
4620
4625
4630
4635
4640
4645
4650
4655
4660
4665
4670
4675
4680
4685
4690
4695
4700
4705
4710
4715
4720
4725
4730
4735
4740
4745
4750
4755
4760
4765
4770
4775
4780
4785
4790
4795
4800
4805
4810
4815
4820
4825
4830
4835
4840
4845
4850
4855
4860
4865
4870
4875
4880
4885
4890
4895
4900
4905
4910
4915
4920
4925
4930
4935
4940
4945
4950
4955
4960
4965
4970
4975
4980
4985
4990
4995
5000
5005
5010
5015
5020
5025
5030
5035
5040
5045
5050
5055
5060
5065
5070
5075
5080
5085
5090
5095
5100
5105
5110
5115
5120
5125
5130
5135
5140
5145
5150
5155
5160
5165
5170
5175
5180
5185
5190
5195
5200
5205
5210
5215
5220
5225
5230
5235
5240
5245
5250
5255
5260
5265
5270
5275
5280
5285
5290
5295
5300
5305
5310
5315
5320
5325
5330
5335
5340
5345
5350
5355
5360
5365
5370
5375
5380
5385
5390
5395
5400
5405
5410
5415
5420
5425
5430
5435
5440
5445
5450
5455
5460
5465
5470
5475
5480
5485
5490
5495
5500
5505
5510
5515
5520
5525
5530
5535
5540
5545
5550
5555
5560
5565
5570
5575
5580
5585
5590
5595
5600
5605
5610
5615
5620
5625
5630
5635
5640
5645
5650
5655
5660
5665
5670
5675
5680
5685
5690
5695
5700
5705
5710
5715
5720
5725
5730
5735
5740
5745
5750
5755
5760
5765
5770
5775
5780
5785
5790
5795
5800
5805
5810
5815
5820
5825
5830
5835
5840
5845
5850
5855
5860
5865
5870
5875
5880
5885
5890
5895
5900
5905
5910
5915
5920
5925
5930
5935
5940
5945
5950
5955
5960
5965
5970
5975
5980
5985
5990
5995
6000
6005
6010
6015
6020
6025
6030
6035
6040
6045
6050
6055
6060
6065
6070
6075
6080
6085
6090
6095
6100
6105
6110
6115
6120
6125
6130
6135
6140
6145
6150
6155
6160
6165
6170
6175
6180
6185
6190
6195
6200
6205
6210
6215
6220
6225
6230
6235
6240
6245
6250
6255
6260
6265
6270
6275
6280
6285
6290
6295
6300
6305
6310
6315
6320
6325
6330
6335
6340
6345
6350
6355
6360
6365
6370
6375
6380
6385
6390
6395
6400
6405
6410
6415
6420
6425
6430
6435
6440
6445
6450
6455
6460
6465
6470
6475
6480
6485
6490
6495
6500
6505
6510
6515
6520
6525
6530
6535
6540
6545
6550
6555
6560
6565
6570
6575
6580
6585
6590
6595
6600
6605
6610
6615
6620
6625
6630
6635
6640
6645
6650
6655
6660
6665
6670
6675
6680
6685
6690
6695
6700
6705
6710
6715
6720
6725
6730
6735
6740
6745
6750
6755
6760
6765
6770
6775
6780
6785
6790
6795
6800
6805
6810
6815
6820
6825
6830
6835
6840
6845
6850
6855
6860
6865
6870
6875
6880
6885
6890
6895
6900
6905
6910
6915
6920
6925
6930
6935
6940
6945
6950
6955
6960
6965
6970
6975
6980
6985
6990
6995
7000
7005
7010
7015
7020
7025
7030
7035
7040
7045
7050
7055
7060
7065
7070
7075
7080
7085
7090
7095
7100
7105
7110
7115
7120
7125
7130
7135
7140
7145
7150
7155
7160
7165
7170
7175
7180
7185
7190
7195
7200
7205
7210
7215
7220
7225
7230
7235
7240
7245
7250
7255
7260
7265
7270
7275
7280
7285
7290
7295
7300
7305
7310
7315
7320
7325
7330
7335
7340
7345
7350
7355
7360
7365
7370
7375
7380
7385
7390
7395
7400
7405
7410
7415
7420
7425
7430
7435
7440
7445
7450
7455
7460
7465
7470
7475
7480
7485
7490
7495
7500
7505
7510
7515
7520
7525
7530
7535
7540
7545
7550
7555
7560
7565
7570
7575
7580
7585
7590
7595
7600
7605
7610
7615
7620
7625
7630
7635
7640
7645
7650
7655
7660
7665
7670
7675
7680
7685
7690
7695
7700
7705
7710
7715
7720
7725
7730
7735
7740
7745
7750
7755
7760
7765
7770
7775
7780
7785
7790
7795
7800
7805
7810
7815
7820
7825
7830
7835
7840
7845
7850
7855
7860
7865
7870
7875
7880
7885
7890
7895
7900
7905
7910
7915
7920
7925
7930
7935
7940
7945
7950
7955
7960
7965
7970
7975
7980
7985
7990
7995
8000
8005
8010
8015
8020
8025
8030
8035
8040
8045
8050
8055
8060
8065
8070
8075
8080
8085
8090
8095
8100
8105
8110
8115
8120
8125
8130
8135
8140
8145
8150
8155
8160
8165
8170
8175
8180
8185
8190
8195
8200
8205
8210
8215
8220
8225
8230
8235
8240
8245
8250
8255
8260
8265
8270
8275
8280
8285
8290
8295
8300
8305
8310
8315
8320
8325
8330
8335
8340
8345
8350
8355
8360
8365
8370
8375
8380
8385
8390
8395
8400
8405
8410
8415
8420
8425
8430
8435
8440
8445
8450
8455
8460
8465
8470
8475
8480
8485
8490
8495
8500
8505
8510
8515
8520
8525
8530
8535
8540
8545
8550
8555
8560
8565
8570
8575
8580
8585
8590
8595
8600
8605
8610
8615
8620
8625
8630
8635
8640
8645
8650
8655
8660
8665
8670
8675
8680
8685
8690
8695
8700
8705
8710
8715
8720
8725
8730
8735
8740
8745
8750
8755
8760
8765
8770
8775
8780
8785
8790
8795
8800
8805
8810
8815
8820
8825
8830
8835
8840
8845
8850
8855
8860
8865
8870
8875
8880
8885
8890
8895
8900
8905
8910
8915
8920
8925
8930
8935
8940
8945
8950
8955
8960
8965
8970
8975
8980
8985
8990
8995
9000
9005
9010
9015
9020
9025
9030
9035
9040
9045
9050
9055
9060
9065
9070
9075
9080
9085
9090
9095
9100
9105
9110
9115
9120
9125
9130
9135
9140
9145
9150
9155
9160
9165
9170
9175
9180
9185
9190
9195
9200
9205
9210
9215
9220
9225
9230
9235
9240
9245
9250
9255
9260
9265
9270
9275
9280
9285
9290
9295
9300
9305
9310
9315
9320
9325
9330
9335
9340
9345
9350
9355
9360
9365
9370
9375
9380
9385
9390
9395
9400
9405
9410
9415
9420
9425
9430
9435
9440
9445
9450
9455
9460
9465
9470
9475
9480
9485
9490
9495
9500
9505
9510
9515
9520
9525
9

invention. In particular, the separate blocks of the various block diagrams represent

functional blocks of methods or apparatuses and are not necessarily indicative of

physical or logical separations or of an order of operation inherent in the spirit and

scope of the present invention. For example, the various blocks of Figure 1 (for

5 example) may be integrated into components, or may be subdivided into components.

Similarly, the blocks of Figure 4 (for example) represent portions of a method which, in

some embodiments, may be reordered or may be organized in parallel rather than in a

linear or step-wise fashion. The present specification and figures are accordingly to be

regarded as illustrative rather than restrictive.